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# Resources Evaluation Newsletter

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Technical Article 1

## IMGRID AS A TOOL FOR WILDLIFE PLANNING

by
Stan Davis[1]

The future of North America's wildlife resources depends on more than just our understanding of wildlife ecology. Since wildlife is a public resource, its status and use depend on effective multiple-use policies. Prior to the mid-1960's, economics rather than ecological considerations dictated land and water uses. Fortunately this situation is changing, but the importance of wildlife provisions in multiple-use planning is still not universally recognized.

Rapid land-use changes have resulted in widespread loss of wildlife habitat and the decline of many wildlife populations. To reduce these losses and declines, biologists must create a favorable climate for the inclusion of wildlife interests in land-use decisions. To effectively communicate with land-use decision-makers, wildlife managers must work together to make objective assessments of habitat value and predictions of the impacts of proposed land management alternatives. Planning tools and decision processes are available to develop informed comparisons and tradeoffs.

This paper describes a computer-assisted data-handling tool, IMGRID, and its application to resource management planning, using as an example a cooperative project undertaken by the Tennessee Wildlife Resources Agency (TWRA) and the Tennessee Valley Authority (TVA). A brief review of the IMGRID system, its previous TVA applications, and an overview of the TWRA-TVA project is presented. Also described is the application of the system to identifying and evaluating wildlife habitats, including long-term management implications.

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### INTRODUCTION TO IMGRID

IMGRID - Information Management on a Grid Cell System (Holmes and Jolly 1980) is a computer system designed to assist planners and natural resource managers in handling complex factors in planning for resource utilization and predicting probable impacts. Developed at Harvard University (Sinton 1976) as a teaching tool, IMGRID requires no previous experience with computers. It is controlled through a series of keyword instructions, each performing a defined operation within a data-file structure permitting the user to process each geographically registered data variable.

In many instances, IMGRID can supplement or replace conventional means of data management and analysis. However, it can never substitute for the user's professional judgment. The results are dependent on the user and not the system. No tool, including this one, voids the need for a site inspection. Although IMGRID can be used to indicate sites with a high probability of satisfying all of the user-defined characteristics, ultimately, decisions are made by rational decision-makers who interpret analytical results and choose among viable alternatives.

### Previous TVA Applications

IMGRID has been selected for a variety of TVA planning and outside technical assistance projects. It has been applied successfully in project planning, community planning, and land management planning activities in TVA and other Federal, State, and local planning agencies.

Project planning is conducted for a particular structure or facility, usually confined to a relatively small geographic area, but often having regional impacts. Examples include power plant siting, transmission corridor routing, and sanitary landfill site screening.

Community planning efforts attempt to influence and manage patterns of growth, expansion, and development through comprehensive land capability analyses, conflict identification, and subsequent land-use modifications. Examples include land-capability and environmental-suitability studies with local planning agencies in Knox, Hamilton, and Putnam Counties, Tennessee.

Land management planning is the formulation of a scheme to capitalize upon the benefits of the land as a productive resource considering both short- and long-term objectives. Examples include help to consulting foresters with forest resource development; assistance to managers of one of the Nation's largest urban parks in Davidson County, Tennessee; and a TVA study to determine soil characteristics that can indicate flooding potential.

## THE CATOOSA PROJECT

Realizing that an ever-expanding population and technology is producing greater demands for all our natural resources, TWRA, in 1974, made planning one of its major activities (TWRA 1977). Contacts were made with TVA, among others, to determine if any existing planning tools or decision processes were available that might fulfill their needs. IMGRID was chosen as an appropriate tool, and a TVA-developed decision process (Howard and Baxter 1976) was used to help structure the project and assure consideration of all relevant circumstances and pertinent information derived from the analyses. The Catoosa project described here represents the initial attempt to facilitate long-term and continuous multiple-benefit wildlife and land management planning.

The computer software has been transferred to the State, and personnel training has been provided. Currently, TVA is providing further technical support in expanding the application of this tool on other TWRA lands.

### Description of the Area and Existing Uses

The 32,376-hectare (80,000-acre) Catoosa Wildlife Management Area is located in middle Tennessee within the Cumberland Plateau physiographic province. It stretches 41.8 kilometers (26 miles) east to west with minimum and maximum elevations of 311 and 770 meters (950 and 2,350 feet), respectively. The area is almost entirely forested with eastern deciduous hardwoods, some mixed hardwood-pine, and limited pure yellow pine stands. However, typical of this region, Catoosa has had a history of heavy cutting and frequent burning. Combined with infertile, thin, well-drained soils which make water availability a frequent problem, the area is generally low in inherent productivity. Purchased by the State in 1942 (Tennessee Game and Fish Commission 1954), the area has only recently begun to show positive response to land management, fire protection, and restricted timber cutting.

The Catoosa area currently supports a wide variety of nonconsumptive and consumptive users; a major increase has been noted in outdoor recreational uses. Attracted by adjacent commercial recreation developments, such as Fairfield Glades and Campout USA, and the Obed National Wild and Scenic River System which flows through the area, sightseers and white water canoeists have visited in increasing numbers. Additionally, the area has been under increasing pressure from campers, hikers, off-road vehicle users, horseback riders, and many visitors seeking enjoyment from wildlife-oriented recreational activities. However, there is also increasing pressure to extract petroleum, coal, and other mineral resources presently under the management area and in the region.

Consumptive recreational uses (primarily hunting) are given the highest priority in terms of the State's financial investment. TWRA provides managed hunting opportunities and both pond and stream fishing. In recent years the largest number of participants were hunters seeking white-tailed deer (*Odocoileus virginianus*) and European wild hog (*Sus scrofa*). However, these big game hunters represent the smallest percentage increase recorded among consumptive recreation user groups. The largest percentage increase in use was in the number of small game hunters (personal correspondence from Reid Tatum, TWRA Region III Manager, March 1979). This phenomenon has been attributed to a significant shift in demand due to small game habitat losses continuing to occur on private lands.

Thus, on Catoosa, a situation prevails where large numbers of nonconsumptive recreationists share the area with consumptive recreationists (hunters), and an increasing frequency of real and potential resource management conflicts is probable.

## METHODS

The analysis capabilities of IMGRID have proven successful in helping to evaluate the Catoosa area so that a number of management objectives can be addressed. These capabilities include: (1) restructuring data values, (2) logical combinations or coincidence, (3) analysis of spatial relationships, and (4) mathematical manipulation. They were used primarily during the data-analysis phase of the decision process.

Using criteria developed during the data-needs determination process, we used analyses in attempts to identify types and intensities of management or development that were compatible among themselves and with the resource base. Management and development interests were represented on a planning team, and their analyses addressed wildlife, forestry, fisheries, and recreation objectives.

Accessing a data base containing 30 variables encoded at a 1.08-hectare (2.68-acre) resolution,

planning team members identified criteria addressing objectives from their respective disciplinary perspectives. Later, these analyses were compared to identify and resolve conflicts where suitable sites occurred that could potentially accommodate a number of objectives. Examples of analyses prepared from the single disciplinary perspective were forest-site potential, recreation facility and day-use areas, fisheries habitat vulnerability, and wildlife habitat suitability.

Wildlife Habitat Evaluation

The most critical factor in any wildlife habitat evaluation methodology is the ability of scientists to define the components that compose the habitat. The results of the evaluation are a delineation of relatively homogeneous areas which are of differential suitability in meeting the requirements of a particular species. Because all habitat requirements are not fully understood, suitability ranking must be general; however, it must also be specific enough to identify major differences in habitat quality. Further, these units must be of sufficient size and character to be located, mapped, and managed on the ground.

The Catoosa planning team members representing wildlife management concerns have not only a detailed biological knowledge of the game species but also many years of work experience on the area. Suitability analyses, using their input, were prepared to rank the area's capability to support populations of deer, hogs, and turkeys. The habitat requirements of the species were outlined first. Then criteria were developed to identify components of the habitat based upon that specific requirement.

An excellent example of how IMGRID can be applied is given in the following section pertaining to wild turkey (*Meleagris gallopavo*) habitat management at Catoosa.

Wild Turkey Habitat Suitability

Habitat requirements were categorized as food, water, cover, reproductive, special, and interspersion. Seasonal availability of certain components of the habitat were considered (i.e., insect availability, especially important to poults). Also, the reproductive requirements were addressed by a spring nesting evaluation that considered only selected habitat components. In the overall habitat suitability ranking process, seven components were treated as separate IMGRID analysis steps, weighted to represent relative importance and combined.

Components considered important in examining the food requirements were: (1) hard mast, i.e., acorns, *Quercus* spp., and beech nuts, *Fagus grandifolia*; (2) soft mast, i.e., dogwood, *Cornus florida*, and black gum, *Nyssa sylvatica*; (3) greens, i.e., various grasses (Gramineae), sedges (Cyperaceae), and other herbaceous plants, buds, and seeds; and (4) insects, mostly of the orders Orthoptera (grasshoppers) and Coleoptera (various beetles). The availability of (5) surface water was a component, considered in relation to its proximity to other components and seasonal availability. Cover and special habitat requirements were accounted for in (6) an escape cover component and (7) a roosting site component. The interspersion requirement (all habitat components available within a one-square-mile range) was reconciled by executing proximity analyses identifying a specified radius around certain components. This was done prior to combining selected components to derive the final suitability rankings.

Once the habitat requirements and the pertinent components were defined, the next steps were: (1) select from the data base those variables most pertinent and (2) translate the habitat criteria into IMGRID manipulations. The purpose was to evaluate the extent of known physical habitat features, vegetative compositions, or structures or to relate site characteristics where certain conditions predominate. The objective of the wildlife managers was to increase the quality and quantity of the habitat through management, thus increasing the probability of positive population responses.

For example, data used to identify areas that met the requirements for hard mast production were forest cover type, forest age classes, and forest stocking classes. In developing criteria, wildlife biologists decided oak-hickory cover types greater than 30 years of age with high (greater than 60 square feet basal area) stocking would have the highest probability of providing hard mast. Areas producing soft mast were identified by relating site characteristics, i.e., land type and aspect, where particular tree, shrub, and fruiting vine species are predominant.

Habitat Suitability Ranking

In deriving the final habitat composites, TWRA wanted to evaluate spring nesting and fall habitats. To reckon with the interspersion requirement and seasonal availability of certain habitat components, proximity analyses were conducted relating: (1) distance to water and (2) distance to roosting sites. A .8-kilometer (one-half-mile) radius was established around water sources that were expected to be available in the fall and a .4-kilometer (one-quarter-mile) radius from all water sources was identified for the spring. The same seasonal proximity relationships were imposed on roosting sites, the rationale being that turkeys do reduce their ranges in the spring around prime nesting habitat, of which water and roosting sites are important parameters.

Finally, in developing the spring nesting and fall habitat composite, the habitat components were compared and individually weighted against one another. The higher the weight, the more

important the component and the more influential it is in determining the composite results. The fall habitat analysis included six weighted components (all previously mentioned components except insect availability) and the spring evaluation combined insect availability, proximity to water, and proximity to roosting sites. In the composite production process, IMGRID's mathematical manipulation function was used to sum the values within the same cell through the specified number of components; the higher the final value, the greater the number of desirable conditions existing in the cell or within an acceptable distance (Taft and Davis 1978).

## DISCUSSION

After field checking and comparison with past records and surveys, the Catoosa biologists felt that substantial information had been gained which would prove useful in their habitat management activities. As previously discussed, however, wildlife habitat information is only one input to the agencies' multiple-use policies, and must, therefore, be evaluated in conjunction with other objectives. IMGRID has been utilized effectively to conduct analyses addressing other objectives. It is also being used to compare analysis results to identify and resolve potential conflicts, particularly with proposed development impacts on existing prime wildlife habitat.

When the planning team convenes to resolve conflicts, final computer analyses and conventional field maps will be prepared combining management objectives to provide the basis for a detailed plan or series of selected compartment prescriptions. After the five-year plan is prepared and integrated with existing management activities, it will be reviewed, revised as often as conditions warrant, and scheduled for implementation. Additionally, computer manipulations simulating future predicted changes in use, natural succession, or resource modifications resulting from imposed management will be compared to predict long-term impacts and trends.

By considering wildlife and other objectives simultaneously and along with existing and proposed uses, management can be made more cost effective by more appropriate site placement and timing. Also, it is likely that detrimental impacts can be minimized, thereby releasing funds for purposes other than maintenance and restoration.

## CONCLUSIONS

This project and the future commitment to the use of IMGRID by TVA and TWRA has begun to bridge the gap between computer technology development and transfer, and ultimate user benefits. This technology assists wildlife managers in making daily decisions regarding resource management and planning with a maximum of pertinent information. The use of a computer in a decision process does not reduce the need for rational decision-making or replace the role of competent field specialists. Rather, a new level of involvement is created and an individual becomes more active, aware, and able to contribute to the ultimate decisions. Upon careful application and sufficient definition of the problems and objectives, computer techniques can prove to be of substantial benefit. In addition to the obvious benefits from increased speed, accuracy, and consistency, the ability to communicate criteria upon which decisions have been based is greatly enhanced. This can be important in long-term management where objectives and other circumstances change rapidly.

Lastly, such a system as IMGRID allows the resource manager to visualize the "big picture" by maintaining accurate, up-to-date data bases permitting a snapshot observation of existing conditions and resources in the target area.

## LITERATURE CITED

Holmes, D. D. and R. L. Jolly. 1980. IMGRID Version 3.5 Users Manual. Tennessee Valley Authority, Office of Natural Resources, Norris, Tennessee. 508 p.

Howard, E. E. and F. Paul Baxter. 1976. A Team Approach to Resource Management Decision-Making. Technical Note B16. Tennessee Valley Authority, Office of Natural Resources, Norris, Tennessee. 23 p.

Sinton, D. F. 1976. An Introduction to IMGRID--an Information Manipulation System for Grid Cell Data Structures. Dept. of Landscape Architecture, Harvard Graduate School of Design, Cambridge, Massachusetts.

Taft, K. A., Jr. and S. E. Davis. 1978. Integrated Forest Wildlife Management Through Graphical Analysis. Tennessee Valley Authority, Office of Natural Resources, Norris, Tennessee. (Proc. Eighth World Forestry Congress, Jakarta, Indonesia.)

Tennessee Game and Fish Commission [presently the Tennessee Wildlife Resource Agency]. 1954. The Catoosa Wildlife Management Area - Cumberland and Morgan Counties. Tennessee Game and Fish Commission, Nashville, Tennessee. 34 p.

Tennessee Wildlife Resources Agency. 1977. A Strategic Plan for Tomorrow's Wildlife Resources Management. Federal Aid in Wildlife Restoration Project FW4. 69 p.

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## INTERAGENCY WILDLIFE GROUP (IWG) ACTIVITIES

The draft RPA Information Needs Assessment (INA), recently completed by the National Analysis

Project of the Resources Evaluation Techniques (RET) Program, has been reviewed. Comments and suggestions have been made to the Analysis Project Leader (Tom Hoekstra) concerning how the INA meets common national wildlife and fish information needs of the agencies represented in the IWG, and points out any additional needs which the IWG feels were either not addressed or not adequately covered in the INA. The IWG agrees with the conceptual analysis model developed from the INA in order to identify Resources Planning Act/National Forest Management Act assessment information needs. The analysis model is based on the concept that the current or projected quantity of any ecosystem product is determined by three factors:

1. The amount and quality of a product (such as wildlife) the ecosystem produces without management;

2. Additional quantity and quality of a product (such as wildlife) resulting from management directed at that product in the ecosystem;

3. Effect on the quantity and quality of other products (such as timber) resulting from management drected at a product (such as wildlife) in the ecosystem.

A first draft of the problem analysis for the National Analysis Project of the RET Program has been completed. The central theme of this problem analysis, which is being addressed as a separate problem area, is to develop evaluation procedures for determining multi-resource use interactions. The IWG has contributed primarily toward the completion of a section of the overall problem analysis which deals with developing ecological analysis techniques for national assessments of wildlife and fish resources. Drafts of other sections for this multi-resource problem analysis which have been completed are:

1. Definition of information requirements for national assessments;

2. Techniques for assessing the nation's physical and economic supplies of timber products;

3. Techniques for assessing the nation's range resources, considering natural forage supplies and forage resources available from cropland and improved pasture.

The first draft of a study plan completed by the IWG, based on the problem analysis, was an <u>interagency</u> wildlife and fish information needs assessment plan to supplement the recently completed RPA Information Needs Assessment and provide interagency scope to the document.

Mr. Jack H. Berryman, Executive Vice President of the International Association of Fish and Wildlife Agencies, met with staff of the RET/IWG on July 18 to become more familiar with the RET Program and activities of the IWG. Mr. Berryman also provided guidance on how the program could best meet the resource management needs of state fish and wildlife agencies. Mr. Robert Nelson, Deputy Director of Wildlife and Fisheries, Forest Service (Washington Office), National Forest System, visited the RET Program on August 4-5 to discuss and plan coordination of wildlife and fish activities of the RET Program with the National Forest System program. In that regard, Mr. Dale Wills, Wildlife Biologist for the Forest Service, Region 2 (Denver) has been assigned the responsibility of coordinating with the RET/IWG, and serves as the National Forest System representative.

The chairman of the IWG, Jim Whelan, participated in the development of a draft 5-year strategy plan for the Habitat Classification and Evaluation Section of the Office of Biological Services. Responsibility for the development of this draft plan was assigned to the FWS Western Energy and Land Use Team (WELUT). Many of the objectives and proposed studies in the 5-year plan complement research and development efforts in the wildlife and fish resource section of the RET Program, and afford good opportunities for cooperative efforts between WELUT and RET.

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Technical Article 2

## COMPLETE TALLY VERSUS SAMPLE CRUISE

by
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and
David O. Yandle[1]

ABSTRACT

A method is given for determining whether complete tally or sample cruising is more efficient for volume estimation on a given tract. A useful approximation for this determination is derived.

When foresters are asked to estimate the volume of timber on a given tract, one of their first decisions is whether to visit, measure, and perhaps mark each merchantable tree, or cruise the tract using fixed-area plots or point sampling. In many situations the choice is obvious: a complete tally would be used on a 5-acre tract, but a 50,000-acre tract would be cruised with plots or point samples. It would be helpful, however,

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to determine the point at which it is as efficient to visit each merchantable tree on a tract as to sample cruise the tract.

## Procedure

The total time spent on a complete tally can be calculated as:

$$T_1 = N\ (t_1 + m_1)\ A \qquad (1)$$

where: $T_1$ = total time in minutes

$N$ = number of merchantable trees per acre

$t_1$ = average travel time per tree in minutes

$m_1$ = average measurement time per tree in minutes

$A$ = acres in tract

The total time spent sample cruising can be determined using the approach given by Zeide (1980) and Wiant and Yandle (in press), as:

$$T_2 = n\ (t_2 + m_2) \qquad (2)$$

where: $T_2$ = total time in minutes

$n$ = number of fixed-area plots or point samples

$t_2$ = average travel time per plot or point in minutes

$m_2$ = average measurement time per plot or point in minutes

It is now only necessary to express these equations in terms of tract size and find the point where the equations intersect. At that point, the time to complete tally or sample cruise is equal; for smaller tracts a complete tally is more efficient, and for larger tracts sample cruising is more efficient.

## An Example

Let us assume in a given area there are 100 sawtimber-size trees per acre (N = 100). If the average travel rate for a timber marker between trees is 2 miles per hour (176 feet per minute), then average travel time per tree ($t_1$) can be estimated as average distance between trees divided by average rate of travel, or:

$$t_1 = (43560/100)^{\frac{1}{2}}/176$$
$$= .12 \text{ minute}$$

We will assume that dbh's are measured with a Biltmore stick and most heights are estimated with $m_1$ = .3 minute per tree. Formula (1) becomes:

$$T_1 = 100\ (.12 + .3)\ A \qquad (3)$$
$$= 42A$$

Although there is no sampling error, in a statistical sense, when volume is estimated for each tree in the population of interest, we must accept a sampling error when sample cruising timber. If the coefficient of variation (CV) for volume on 1/5-acre plots is 100 percent, a sampling error (E) of ± 6 percent with a probability of two-thirds is adequate for the timber values involved, and completely random sampling is assumed,

$$n = \frac{t^2 CV^2}{E^2} \qquad (4)$$

$$= \frac{(1)^2\ (100)^2}{(6)^2}$$

$$= 278$$

We can estimate travel time per plot, assuming an average rate of speed of 2 miles per hour, as:

$$t_2 = (43560A/n)^{\frac{1}{2}}/176 \qquad (5)$$

$$= (43560A/278)^{\frac{1}{2}}/176$$

$$= .07A^{\frac{1}{2}}$$

If this is a sawtimber cruise, a reasonable measurement time per plot ($m_2$) is 10 minutes. Equation (2) becomes:

$$T_2 = 278\ (.07A^{\frac{1}{2}} + 10) \qquad (6)$$

$$= 19.5A^{\frac{1}{2}} + 2780$$

To find the point of intersection, we set $T_1 = T_2$, or

$$42A = 19.5A^{\frac{1}{2}} + 2780 \qquad (7)$$

If we let $A = X^2$, equation (7) can be expressed as:

$$42X^2 - 19.5X - 2780 = 0 \qquad (8)$$

And, by the quadratic equation:

$$X = \frac{-(-19.5 \pm [(-19.5)^2 - (4)\ (42)\ (-2780)]^{\frac{1}{2}}}{(2)(42)} \qquad (9)$$

$$= 8.37$$

Therefore, the tract size at which the cost of a complete tally and sample cruising is equal is $(8.37)^2$ or A = 70 acres. A simple graphic determination gives the same result (Figure 1).

## An Approximation

It is obvious that the greater the precision required, the smaller the E-value and/or the larger the t-value, the larger the tract size for which a complete tally will be more efficient than sample cruising. A useful approximation of the point of intersection for most practical situations is:

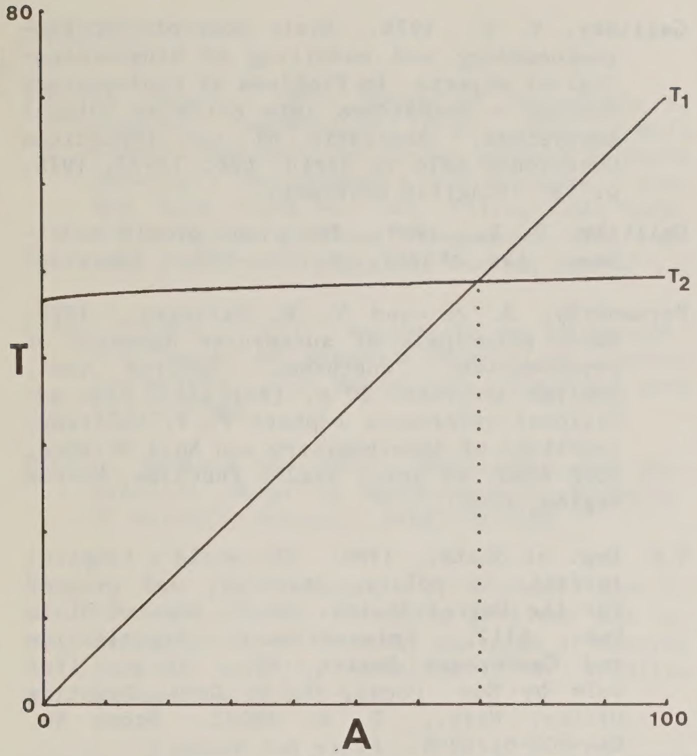


Figure 1. Graphic determination of point of intersection, with A in acres and T in hours.

$$A = \frac{n\ m_2}{N(t_1 + m_2)} \tag{10}$$

For our example:

$$A = \frac{(278)\ (10)}{100\ (.12 + .3)}$$

$$= 66 \text{ acres}$$

The derivation of this approximation is given in the appendix.

## Appendix

The general form of the relationship given by equation (9), but in squared form so as to express tract size directly in acres, is:

$$A = n \left\{ \frac{21780}{N^2(t_1+m_1)^2 S_2^2} + \frac{m_2}{N(t_1+m_1)} \pm 21780 \left[ \frac{1}{N^4\ (t_1+m_1)^4 S_2^4} + \frac{m_2}{10890 N^3\ (t_1+m_1)^3 S_2^2} \right]^{\frac{1}{2}} \right\} \tag{11}$$

where $S_2$ is the average rate of speed in travel between plots, and all other variables are as previously defined. Inspection of the equation in this form shows that the tract size, A, at which equality of sample cruising and a complete tally occurs, increases as either n or $m_2$ increase, and decreases as any of the other variables are increased.

It should also be noted that the second term in equation (11) is the dominant term when all of the variables are in a realistic range and travel time between plots is small relative to the measurement time per plot.

If travel time between plots is relatively small and is thus ignored, the equality is reduced to

$$N(t_1 + m_1)A = nm_2$$

or

$$A = \frac{nm_2}{N(t_1 + m_1)}, \tag{12}$$

which is exactly the dominant term in equation (11), and is the approximation used in the preceding example. The small slope of the curve $T_2$ in the region of the intersection with $T_1$, as shown in Figure 1, illustrates the efficacy of the approximation.

## Literature Cited

Wiant, H. V., Jr., and D. O. Yandle. Optimum plot size for cruising sawtimber in eastern forest stands. (In Press).

Zeide, B. 1980. Plot size optimization. Forest Science 26:203-215.

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## CALL FOR PAPERS

Contributed papers are now being sought for a national workshop on INPLACE RESOURCE INVENTORIES to be held August 9-14, 1981 at Orono, Maine. The workshop is sponsored by the American Society of Photogrammetry, the Society of American Foresters' Inventory and Remote Sensing Working Groups, the Society for Range Management, the Wildlife Society, and the University of Maine and in cooperation with USDA Forest Service and USDI Bureau of Land Management. Abstracts of "How-to" papers dealing with natural resource classification, mapping, sampling designs or information management systems should be sent to H. Gyde Lund, Orono Program Chairman, USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, 240 West Prospect St., Fort Collins, CO 80526 (phone (303) 221-4390, ext. 202 or FTS 323-1202) by February 28, 1981.

The number of papers that can be accepted will be limited. Final selection will be made by April 15, 1981 and will be based upon appropriateness to the theme of the workshop. International participation is welcomed.

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Short Courses Slated

Colorado State University will be offering 3 short courses this coming summer that will be of interest to the reader of R.E.N. Tentatively scheduled are:

The Use of Programmable Calculators in Forestry. July 7-10, 1981.

Regression Methods in Research, July 13-17.

Multilevel Sampling, July 20-24.

For further information contact Dr. W. E. Frayer, College of Forestry and Natural Resources, Colorado State University, Fort Collins, CO 80523. Phone 303/491-6637.

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## CURRENT LITERATURE

Please order directly from sources given in parenthesis ( ). For journal articles, contact your local library for availability.

### GENERAL

Andresen, J. W., and R. A. D. Kelertas. 1979. World directory of urban forestry and arboricultural research workers. Report 0-X-302, 113 p. (Information Office, Great Lakes Forest Research Center, Canadian For. Serv., Dep. of the Environment, Box 490, Sault Ste. Marie, Ontario, P6A 5M7, Canada).

Hegg, Karl M. 1979. Timber resource statistics for the Tuxedni Bay inventory unit, Alaska, 1971. USDA For. Serv. Resource Bull. PNW-88, 43 p. (Pacific Northwest Forest and Range Exp. Stn., 809 NE 6th Ave., Portland, OR 97232).

Jakes, Pamela J., and Gerhard K. Raile. 1980. Timber resource of Minnesota's northern pine unit, 1977. USDA For. Serv. Resource Bull. NC-44, 54 p. (North Central Forest Exp. Stn., 1992 Folwell Ave., St. Paul, MN 55108).

Goodin, J. R. and David K. Northington (editors). 1979. Arid land plant resources. Proceedings of the International Arid Lands Conference on Plant Resources. 724 p. (International Center for Arid and Semi-arid Land Studies, Texas Tech Univ., Lubbock, TX 79409. Price $15).

Yerke, Theodor R. 1979. WESTFORNET: A modern technical information service for forestry serving the western United States.

Navon, Daniel. 1978. Operational forest management planning methods proceedings. USDA For. Serv. Gen. Tech. Rept. PSW-32, 117 p. (Both from Pacific Southwest For. and Range Exp. Stn., P. O. Box 245, Berkeley, CA 94701).

Galitsky, V. V. 1978. Basic concepts of biogeocoenology and modelling of biogeocoenological objects. In Problems of Contemporary Ecology - Researches into Estonian Natural Ecosystems. Abstracts of the Republican Conference held in Tartu, Dec. 11-13, 1978. p. 11. (English abstract).

Galitsky, V. V. 1979. The plant growth modeling. [as above] p. 714-723. (Russian)

Razumovsky, S. M. and V. V. Galitsky. 1979. Basic principals of successive dynamics of phytocenoses. Puschino. Russian text, English abstract. 20 p. (for all 3 plus additional references contact V. V. Galitsky, Institute of Agrochemistry and Soil Science, USSR Acad. of Sci., 142292 Puschino, Moscow Region, USSR).

U.S. Dep. of State. 1980. The world's tropical forests: a policy, strategy, and program for the United States. U. S. Dep. of State Pub. 9117, International Organization and Conference Series 145. 53 p. (for sale by Sup. Docs., U. S. Govt. Printing Office, Wash., D. C. 20402, Stock No. 044-000-01769-5. Price not known.)

### CLASSIFICATION

Hodgkins, Earl J., Michael S. Golden, and W. Frank Miller. 1979. Forest habitat regions and types on a photomorphic - physiographic basis: a guide to forest site classification in Alabama - Mississippi. Southern Coop. Series No. 210, 64 p. (Agric. Exp. Stn., Auburn Univ., Auburn, AL 36830).

Scarpace, F. L., and B. K. Quirk. 1980. Land-cover classification using digital processing of aerial imagery. Photogrammetric Engineering and Remote Sensing 46(8): 1059-1065.

Damman, A. W. H. 1979. The role of vegetation analysis in land classification. Forestry Chronicle 55(5): 175-182.

Anderson, James R., et al. 1976. A land use and land cover classification system for use with remote sensor data. USDI Geological Survey Prof. Paper 964. 28 p.

Loelkes, George L., Jr. 1977. Specifications for land use and land cover and associated maps. USDI Geological Survey Open File No. 77-555, 51 p.

U.S. Geological Survey. 1979. Land use and land cover and associated maps. USDI Geological Survey Brochure 281-363/22. (All 3 from Branch of Distribution, U. S. Geological Survey, 1200 South Eads St., Arlington, VA 22202.)

Ralston, C. W., and D. D. Richter. 1980. Identification of lower coastal plain sites of low soil fertility. Southern Journal of Applied Forestry 4(2):84-88.

INVENTORY

Umbreit, Nancy. 1980. Chemical restraints of reptiles, amphibians, fish, birds, small mammals and selected marine mammals in North America - an annotated bibliography. USDI BLM Tech. Note No. 340, Filing Code 6500. (USDI Bureau of Land Management, DSC, Federal Center, Building 50, Denver, CO 80225.)

Crête, Michel. 1979. Estimation de la densité d'orignaux au moyen d'inventaires aériens incompletes. Le Naturaliste Canadien (106 (4):481-483.

Dapson, Richard W. 1980. Guidelines for statistical usage in age-estimation technics. J. Wildlife Manage. 44(3):541-548.

Fraser, D., E. Reardon, F. Dieten, and B. Loescher. 1980. Sampling problems and interpretation of chemical analysis of mineral springs used by wildlife. J. Wildlife Manage. 44(3):623-631.

Kufeld, Roland C., James H. Olterman, and David C. Bowden. 1980. A helicopter quadrat census for mule deer on Uncompahgre Plateau, Colorado. J. Wildlife Manage. 44(3):632-639.

Oldemeyer, John L., and Wayne L. Regelin. 1980. Comparison of 9 methods for estimating density of shrubs and saplings in Alaska. J. Wildlife Manage. 44(3):662-665.

Arthur, W. J., and A. W. Alldredge. 1980. Seasonal estimates of masses of mule deer fecal pellets and pellet groups. J. Wildlife Manage., 44(3):750-751.

Reese, Gary A., Robert L. Bayn, and Neil E. West. 1980. Evaluation of double sampling estimators of subalpine herbage production. J. Range Manage. 33(4):300-306.

Rutherford, M. C. 1979. Plant-based technique for determining available browse and browse utilization: a review. Botanical Review 45(2):203-228.

Stoddard, Anne M. 1979. Standardization of measures prior to cluster analysis. Biometrics 35(4):765-773.

Abrams, Peter. 1980. Some comments on measuring niche overlap. Ecology 61(1):44-49.

Johnson, Douglas H. 1980. The comparison of useage and availability measurements for evaluating preference. Ecology 61(1):65-71.

Grosenbaugh, L. R. 1980. Avoiding dendrometry bias when trees lean or taper. Forest Science 26:203-215.

Ziede, Boris. 1980. Plot size optimization. Forest Science 26:251-257.

Countryman, Clive M., and William A. Dean. 1979. Measuring moisture content in living chaparral: A field user's manual. USDA For. Serv. Gen. Tech. Rep. PSW-36. 27 p. (from Pacific Southwest Forest and Range Exp. Stn., P. O. Box 245, Berkeley, CA 94701).

Hyra, Ronald. 1978. Methods of assessing instream flows for recreation. USDI Fish and Wildlife Service Instream Flow Information Paper 6, FWS/OBS-78/34. 16 p. plus Appendices. (contact Cooperative Instream Flow Group, 2625 Redwing Road, Fort Collins, CO 80526, for availability.)

Shirazi, M. A., D. H. Lewis, and W. K. Seim. 1979. Monitoring spawning gravel in managed forested watersheds. U. S. Environmental Protection Agency, EPA-600/3-79-014, 13 p. (contact National Technical Information Service, Springfield, VA 22161, for price and availability).

Amidon, Elliot L., and K. Leroy Dolph. 1979. Two cores are better than one: predicting mixed-conifer growth in the Sierra Nevada. USDA For. Serv. Res. Note PSW-340. 3 p. (Publications Distribution, Pacific Southwest Forest and Range Exp. Stn., 1960 Addison St., P. O. Box 245, Berkeley, CA 94701).

Gholston, L. E. 1980. Plant analysis sampling instructions. Pub. 1224. (Cooperative Extension Service, Mississippi State University, Mississippi State, MS 39762).

Leonard, R. E., H. E. Echelberger, H. J. Plumley, and L. W. Van Meter. 1980. Management guidelines for monitoring use on back country trails. USDA For. Serv. Res. Note NE-286. 14 p. (Publications Distribution, Northeast Forest Exp. Stn., 370 Reed Road, Broomall, PA 19008).

ANALYSIS

Smith, Andree Yvonne, and Richard J. Blackwell. 1980. Development of an information data base for watershed monitoring. Photogram. Engin. and Remote Sensing. 46(8):1027-1038.

Gedney, Donald R. 1979. Timber supply projections in the Pacific Northwest. Reprint from Forest Resource Inventories Workshop Proc., Colorado State Univ. p. 188-191.

Clark, Roger N., and George H. Stankey. 1979. The recreation opportunity spectrum: a framework for planning, management, and research. USDA For. Serv. Gen. Tech. Rep. PNW-98, 32 p.

Snell, J. A. Kendall, and James K. Brown. 1980. Handbook for predicting residue weights of Pacific Northwest conifers. USDA For. Serv. Gen. Tech. Rep. PNW-103. 44 p. (the above 3 from Pacific Northwest For. and Range Exp. Stn., 809 NE 6th Ave., Portland, OR 97232).

Saucier, Joseph R. 1979. Estimation of biomass production and removal. In Impact of Intensive Harvesting on Forest Nutrient Cycling. p. 172-189.

Dress, Peter E., and Richard C. Field. 1979. Multi-criterion decision methods in forest resources management. In Proc. Symp. Multiple-Use Management of Forest Resources, Clemson, SC, Sept. 1979. p. 122-157.

Boyce, Stephen G., and Herbert A. Knight. 1980. Prospective ingrowth of southern hardwoods beyond 1980. USDA For. Serv. Res. Paper SE-208. 33 p. (All 3 from Publications Distribution, Room 025, Southeastern Forest Exp. Stn., P. O. Box 2570, Asheville, NC 28802).

Kent, Brian M. 1980. Linear programming in land management planning on National Forests. J. For. 78(8):469-471.

Murphy, Paul A., and Herbert S. Sternitzke. 1979. Growth and yield estimation for loblolly pine in the West Gulf. USDA Forest Serv. Res. Paper SO-154. 8 p.

Farrar, Robert M., Jr. 1979. Status of growth and yield information in the south. Reprint. South. J. Applied For., 3(4): 132-137.

Farrar, Robert M., Jr. 1979. Growth and yield predictions for thinned stands of even-aged natural longleaf pine. USDA Forest Serv. Res. Paper SO-156. 78 p. (Above 3 available from Publication Distribution, Southern Forest Exp. Stn., RM T-10210, Postal Services Bldg., 701 Loyola Ave., New Orleans, LA 70113).

Zarnoch, S. J., and H. E. Burkhart. 1980. A simulation model for studying alternatives in mark-recapture experiments. Ecological Modelling 9(1):33-42.

Johnson, Curtis M. 1980. Computer techniques for land management planning. USDA For. Serv. Res. Note RM-387. 4 p. (Publications Distribution, Rocky Mt. For. and Range Exp. Stn., 240 W. Prospect St., Ft. Collins, CO 80526).

Chen, Chung M., Daetmar W. Rose, and Rolfe A. Leary. 1980. How to formulate and solve optimal stand density over time problems for even-aged stands using dynamic programming. USDA For. Serv. Gen. Tech. Rep. NC-56. 17 p. (North Central Forest Exp. Stn., 1992 Folwell Ave., St. Paul, MN 55108).

Mitchell, William B., et al. 1977. GIRAS: A geographic information retrieval and analysis system for handling land use and land cover data. USDI Geological Survey Prof. Paper 1059. 16 p. (Branch of Distribution, U. S. Geological Survey, 1200 South Eads St., Arlington, VA 22202).

Davis, Lawrence S. 1980. Strategy for building a location specific, multipurpose information system for wildland management. J. For. 78:402-406.

Oderwald, Richard G., William B. Stuart, and Kenneth D. Farrar. 1980. The forest model file: a mapped stand library at Virginia Tech. Forest Science 26:193-194.

Dolph, K. Leroy, and Elliot L. Amidon. 1979. Predicting growth of mixed-conifer species in the Sierra Nevada: rationale and methods. USDA For. Serv. Res. Note PSW-339. 7 p. (Pacific Southwest Forest and Range Exp. Stn., P. O. Box 245, Berkeley, CA 94701).

Boudoux, M., and F. Bonenfant. 1979. SACADOS. Systéme automatique conversationnel d´analyse de donneées statistiques. INF Rep. LAU-X-39(E). 22 p. (Available in English or French from Environment Canada, Centre de Recherches Forestieres des Laurentides, 1080 Du Vallon C. P. 3800, Quebec, Que., Canada G1V 4C7.)

Gates, Charles E. 1980. LINETRAN, a general computer program for analyzing line transect data. J. Wildlife Manage. 44(3):658-661.

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## MEETINGS, WORKSHOPS, AND SYMPOSIA

November 30-December 6, 1980. Arid Land Resource Inventories--Developing Cost Efficient Methods. (La Paz, Mexico). $20. An international workshop sponsored by IUFRO, SAF, Mexican Subsecretariat of Forestry and Wildlife, Mexican Assoc. of Professional Foresters, USDA Forest Service, and USDI Bureau of Land Management. Contact: H. Gyde Lund, USDA Forest Service, 240 W. Prospect St., Ft. Collins, CO 80526. Phone (303) 221-4390, ext. 202.

December 2-5, 1980. Seventy-first Western Forestry Conference. (Victoria, British Columbia). Contact: Western Forestry and Conservation Assn., American Bank Building, Portland, OR 97205.

December 8-11, 1980. National Conference on Renewable Energy Technologies. Contact: Donni S. Hopkins, Conference Coordinator, Hawaii Natural Energy Institute, Univ. of Hawaii at Manoa, 2540 Dole Street, Honolulu, HI 96822. Phone (808) 948-6379.

December 27-29, 1980. Mount St. Helens Holocaust and Aftermath - A Volcano Workshop for Educators. (Portland State University, Portland, Oregon) Fees - $195 for educators, $160 for students. Contact Volcano Workshop Coordinators, Mad River Institute, 616 - 14th St., Arcata, CA 95521. Phone 707/822-0310.

January 5-9, 1981. Methods of Multiple Criteria Optimization in Operations Research and Management Planning. $650. (Miami, Florida). Contact: Director of Professional Education, University Associates, P. O. Box 541, Princeton, NJ 08540. Phone (609) 924-5656.

January 26-31, 1981. Growth and Yield Studies in Mixed, Indigenous Forests. (Los Banos, Phillippines). Sponsored by IUFRO Subject Group S4.01. Contact Prof. Joran Fries, Swedish Univ. of Agricultural Sciences, International Rural Development Center, S-750 07 Uppsala, Sweden.

February 8-13, 1981. Society for Range Management Annual Meeting. (Tulsa, Oklahoma). Contact: Executive Secretary, SRM, 2760 W. 5th Ave., Denver, CO 80204.

February 9-13, 1981. Aerial Photography/Aerial Photo Interpretation. An introductory or refresher course for land managers. $175. Contact: Dr. Joseph J. Ulliman, College of Forestry, Wildlife and Range Sciences, Univ. of Idaho, Moscow, ID 83843. Phone (208) 885-7016.

March 17-20, 1981. The Application of Remote Sensing to Wildlife Habitat Inventory. Contact: P. J. Gutierrez (phone (707) 826-3320) or L. Fox (phone (707) 826-4873). School of Natural Resources, Humboldt State Univ., Arcata, CA 95521.

April 6-11, 1981. Perspectives in Landscape Ecology: Contributions to Research, Planning and Management of Our Environment. (Eindhoven, The Netherlands). Contact: Ms. W. J. M. van Giersbergen, Congress Bureau of the Information Dept. TNO, 148, Juliana van Stolberglaan, 2595 CL The Hague - The Netherlands.

April 21-23, 1981. Eighth Biennial Workshop on Color Aerial Photography in the Plant Sciences and Related Fields. (Shenandoah National Park, Virginia). Contact: Dr. Roy A. Mead, Program Chairman, VPI and State Univ., Blacksburg, VA 24061. Phone (703) 961-5481.

June 22-26, 1981. Dynamics and Management of Mediterranean-type Ecosystems: An International Symposium. (San Diego, California). Contact: Chairman, Dynamics and Management of Mediterranean-type Ecosystems: An International Symposium, Pacific Southwest Forest and Range Exp. Stn., USDA Forest Service, 4955 Canyon Crest Drive, Riverside, CA 92507.

August 9-14, 1981. "INPLACE Resource Inventories --A National Workshop. (Orono, Maine). Sponsored by Society of American Foresters, Society for Range Management, American Society of Photogrammetry, Wildlife Society, and University of Maine. Contact: L. O. House, Great Northern Paper Co., Millinocket, ME 04462. Phone (207) 723-5131.

September 6-17, 1981. Seventeenth IUFRO World Congress. (Kyoto, Japan). Contact: Congress Secretariat, XVII IUFRO World Congress, P. O. Box 16, Tsukuba Norin, Kenkyudanchi-Nai, Ibaraki, Japan 305.

December 1-11, 1981. International Statistical Institute (ISI) (Buenos Aires, Argentina). Bertil Matern is organizing a session on Statistics and Stochastics in Forestry. Contact: Dr. Matern, Dept. of Forest Biometry, Swedish Univ. of Agricultural Sciences, S-750 07 Uppsala, Sweden.

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WANTED--Materials for the Newsletter--feature articles, news items, current literature, and meeting notices. All articles received are to be grammatically and technically correct. Send your material to Resources Evaluation Newsletter, Rocky Mountain Forest and Range Exp. Stn., 240 West Prospect Street, Ft. Collins, CO 80526. Phone: (303) 221-4390, ext. 202 or FTS 323-1202.

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